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(56) Documents Cited

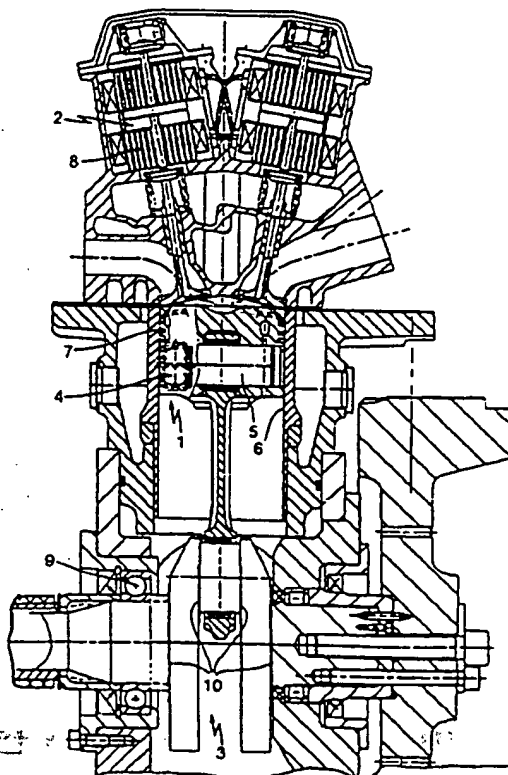
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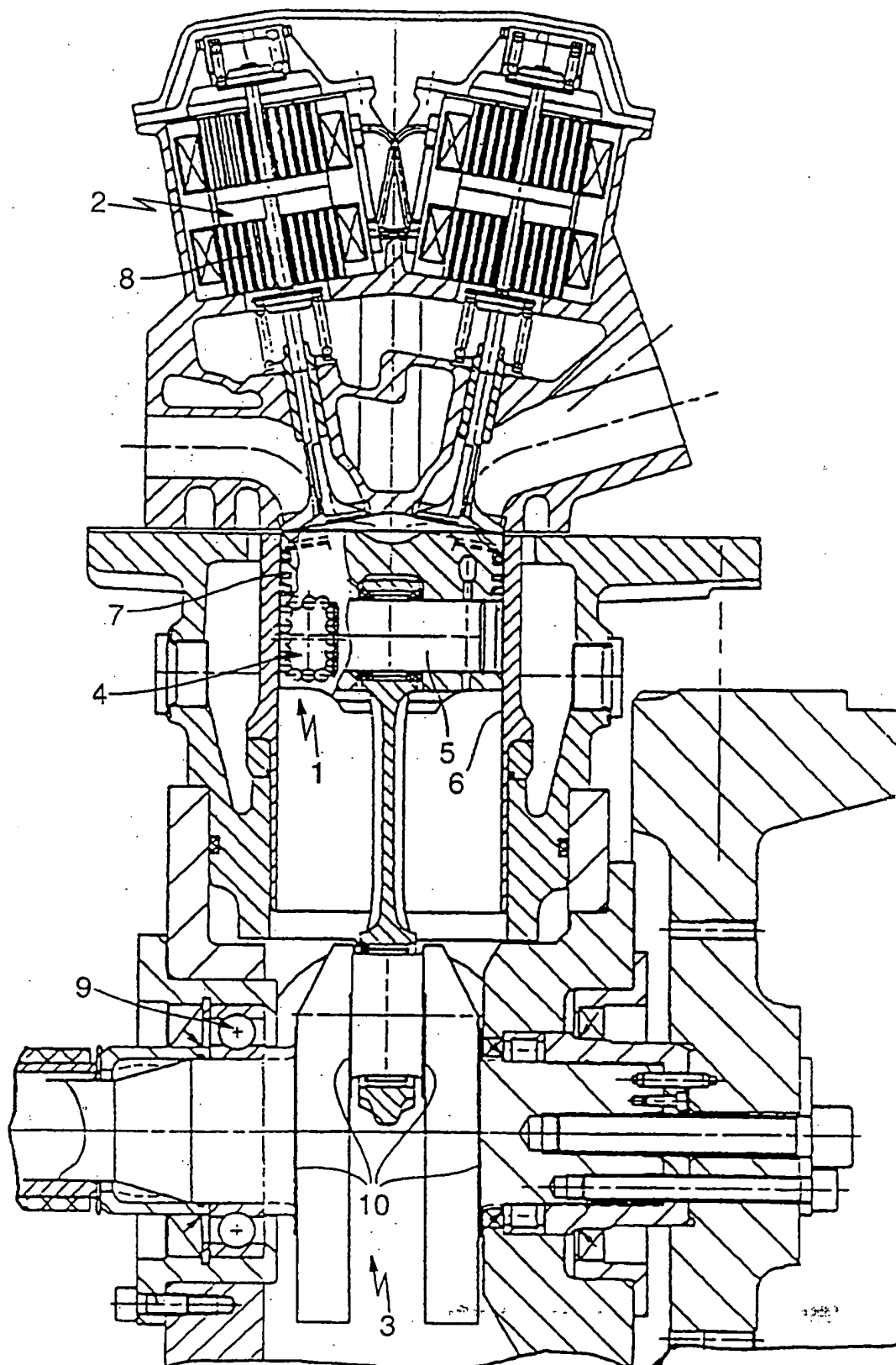
(54) I.e. engine without an overall lubricating oil circuit; it has rolling bearings between piston and cylinder and separate lubrication of valve gear and crank

(57) Each piston 5 has a number of linear rolling bearings 4 which roll along a line on the inner wall of the cylinder liner 6. The bearings 4 may require no lubrication or may have minimum-quantity or lifetime lubrication. The valve gear 2 may be electromagnetic or electrohydraulic, requiring no lubricant. Alternatively, the valve gear may have lifetime, grease or solid lubrication. The main crankshaft 9 bearing and the crankpin/connecting rod bearing 10 may have lifetime lubrication in encapsulated form or may have its own lubricant circuit, eg using diesel fuel as the lubricant. Alternatively, a ferrofluid lubricant may be used, held in place by permanent magnet rings. Engine auxiliaries have respective alternative lubricants or minimum-quantity lubricants. The engine does not need oil-changes, oil consumption is reduced and particle and HC exhaust emissions are reduced.



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Internal combustion engine free of a
lubricating-oil circuit

The invention relates to an internal combustion engine free of a lubricating-oil circuit, having a tribosystem consisting of the piston/liner unit as well as if need be further tribosystems, e.g. valve gear and crank mechanism.

Such an internal combustion engine without a common lubricating-oil circuit for the various tribosystems is described in Patent Specification US 4 846 051. In the tribosystem consisting of the piston/liner unit there, the piston is mounted in the liner by means of a gas-pressure film. The other tribosystems, such as valve gear and crank mechanism, comprise oil-free ceramic rolling bearings in combination with suitable dry lubrication in order to be able to dispense with lubricating oil completely.

The present invention seeks to provide a novel internal combustion engine free of a lubricating-oil circuit of the type mentioned at the beginning which has in particular a very advantageous mounting of the piston of a respective piston/liner unit in the associated liner.

According to the present invention there is provided an internal combustion engine free of a lubricating-oil circuit, having at least one tribosystem consisting of the piston/liner unit, wherein the tribosystem consisting of the piston/liner unit comprises one or more rolling bearings for mounting the piston in the associated liner.

In this engine, the tribosystem consisting of the piston/liner unit comprises one or more rolling bearings with which the respective piston is mounted in the associated liner. This rolling bearing arrangement is preferably designed in such a way that it requires no lubrication at all.

In an internal combustion engine developed according to an embodiment of the invention, the mounting of the respective piston in the associated liner is effected via a plurality of linear rolling bearings which are arranged so as to be distributed over the piston periphery, preferably lying

Rao
2700
100
1000

2700
100
1000

in the transverse direction of the piston.

In an internal combustion engine according to a further embodiment, the further tribosystem consisting of the valve gear is designed as a lubricant-free electromagnetic or electrohydraulic valve control or as a closed lubricating system having lifetime lubrication and therefore does not require repeated lubrication over the lifetime of the engine.

In a further development, the further tribosystem consisting of the crank mechanism is configured in such a way that it, too, does not require repeated oil lubrication.

A preferred embodiment of the invention is shown in the drawing and described below.

The single figure shows a partial longitudinal section through an internal combustion engine free of a lubricating-oil circuit.

The three tribosystems consisting of the piston/liner unit 1, valve gear 2 and crank mechanism 3 can be seen in the view shown of the region of a cylinder of a reciprocating-piston internal combustion engine, for which tribosystems a common lubricating-oil circuit is not provided, in contrast to most conventional internal combustion engines. The mounting of the respective friction partners against one another is instead effected separately in such a way that repeated lubrication of the various bearings is not necessary during the lifetime of the engine.

To this end, the tribosystem consisting of the piston/liner unit 1 specifically contains a plurality of linear rolling bearings 4 which, distributed over the periphery of the respective piston 5 preferably in the transverse direction of the piston, are arranged in corresponding receptacles thereof, each linear rolling bearing 4 lying in a longitudinal plane. During the reciprocating movement of the piston, each linear rolling bearing 4 therefore rolls along an axial line on the inner wall of the associated liner 6. The linear rolling bearings 4 are preferably designed as ball bearings or also as spherical roller bearings which require no lubrication and extend over

a bottom piston-skirt half, adjoining which is a top half 7 with sealing piston rings. If required, they may alternatively be designed as rolling bearings having minimum-quantity lubrication or lifetime lubrication. Instead of the linear rolling bearings 4 shown, other rolling bearings which do not require repeated oil lubrication may also be provided for mounting the respective piston 5 in the associated liner 6. Very reliable guidance of the respective piston 5 in the associated liner 6 is always achieved by the rolling bearing or bearings.

An electromagnetic valve control 8, or alternatively an electrohydraulic valve control, which requires no lubricant is provided for the tribosystem consisting of the valve gear 2, which comprises corresponding cams, tappets and bearings. Alternatively, a closed lubricating system having lifetime lubrication or lubricant lifetime filling may be used for the tribosystem consisting of the valve gear 2. The valve guide and valve seat are provided with minimum-quantity lubrication. A metering device for the lubricant or alternatively grease lubrication is used for this purpose. As a further alternative, dry running with solid lubrication or a coating on the material is possible.

The main bearing 9 of the tribosystem consisting of the crank mechanism 3 is designed as a rolling bearing having lifetime lubrication in encapsulated form.

Alternatively, the main bearing 9 may also be realized as a plain bearing having a separate lubricant circuit, in which case diesel fuel may also be included in addition to the use of oily liquids including synthetic lubricants. A further alternative is to realize the main bearing 9 as a rolling bearing having a ferrofluid lubricant, which is held in the bearing by confining permanent-magnet rings. The bearings 10 on the piston pin and connecting rod of this crank-mechanism tribosystem 3 are designed in a similar manner as encapsulated rolling or plain bearings having lifetime lubrication or as plain bearings having a separate lubricant circuit, in which case diesel fuel may also be included in addition to the use

of oily liquids including synthetic lubricants.

In addition, auxiliary units of the engine, such as pump, filter and piping, are adapted to the omission of a lubricating-oil circuit and to this end contain, for example, a respective alternative lubricant or minimum-quantity lubrication. If need be, some of these auxiliary units may be omitted entirely by dispensing with a lubricating-oil circuit. For the design of the engine coolant circuit, the heat requirement, which is changed compared with a conventional internal combustion engine due to the reduction in the lubricating-oil quantity, is to be taken into account.

On the whole, an engine which is free of a lubricating-oil circuit and thus also does not need an oil change is obtained according to the invention, in which engine the individual tribosystems do not require lubrication or comprise autonomous lubricating systems, rolling bearings being provided in the associated liner of the piston of a respective piston/liner unit for the reliable and durable guidance of the piston. By the omission of the lubricating-oil circuit in the conventional sense, the oil consumption is markedly reduced and thus the particle and HC emission in the exhaust gas is reduced.

Claims

1. An internal combustion engine free of a lubricating-oil circuit, having at least one tribosystem consisting of the piston/liner unit, wherein the tribosystem consisting of the piston/liner unit comprises one or more rolling bearings for mounting the piston in the associated liner.
2. An internal combustion engine free of a lubricating-oil circuit according to Claim 1, wherein a plurality of linear rolling bearings are provided for the tribosystem consisting of the piston/liner unit, which linear rolling bearings are accommodated in the piston in such a way as to be uniformly distributed over its periphery and lying in each case in a longitudinal plane.
3. An internal combustion engine free of a lubricating-oil circuit according to Claim 1 or 2, wherein a lubricant-free electromagnetic or electrohydraulic valve control or a closed lubricating system having lifetime lubrication is provided for the further tribosystem consisting of the valve gear.
4. An internal combustion engine free of a lubricating-oil circuit according to any one of Claims 1 to 3, wherein plain or rolling bearings having lifetime lubrication and/or plain bearings having a separate lubricant circuit are provided for the further tribosystem consisting of the crank mechanism having the main bearings and the bearings of piston pin and connecting rod.
5. An internal combustion engine free of a lubricating-oil circuit, substantially as described herein with reference to, and as illustrated in, the accompanying drawing.



The Patent Office

Application No: GB 9715327.4
Claims searched: 1 to 5

Examiner: John Twin
Date of search: 21 October 1997

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Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F1B (B4B, B4C, B4G, B2P4, B2P5); F2T

Int Cl (Ed.6): F01M 9/00, 9/04, 9/10, 9/12; F16J 1/02

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
Y	GB 1296830 (Kinnersly) - see eg p.1, ll.64-76; p.4, ll.11-27	3,4
X,Y	GB 703402 (Powley)	X:1 Y:3,4
X,Y	GB 349213 (Gruver)	X:1 Y:3,4
X,Y	GB 217312 (Pile)	X:1 Y:3,4
X,Y	US 5437220 (Cheng)	X:1 Y:3,4
X,Y	US 4807577 (Koutsoupidis)	X:1 Y:3,4
X,Y	US 4485728 (Bando)	X:1 Y:3,4
Y	US 4392463 (Nissan) - see eg col.3, ll. 4-19	4
X,Y	US 3398653 (Foster)	X:1 Y:3,4
X,Y	US 2712483 (Ciaccia)	X:1 Y:3,4

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.

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A Document indicating technological background and/or state of the art.
P Document published on or after the declared priority date but before the filing date of this invention.
E Patent document published on or after, but with priority date earlier than, the filing date of this application.



The Patent Office

7

Application No: GB 9715327.4
Claims searched: 1 to 5

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Date of search: 21 October 1997

Category	Identity of document and relevant passage	Relevant to claims
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X,Y	DE 3704114 A1 (Schwarz)	X:1 Y:3,4
X,Y	DE 2938647 A1 (Seelinger)	X:1 Y:3,4

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
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